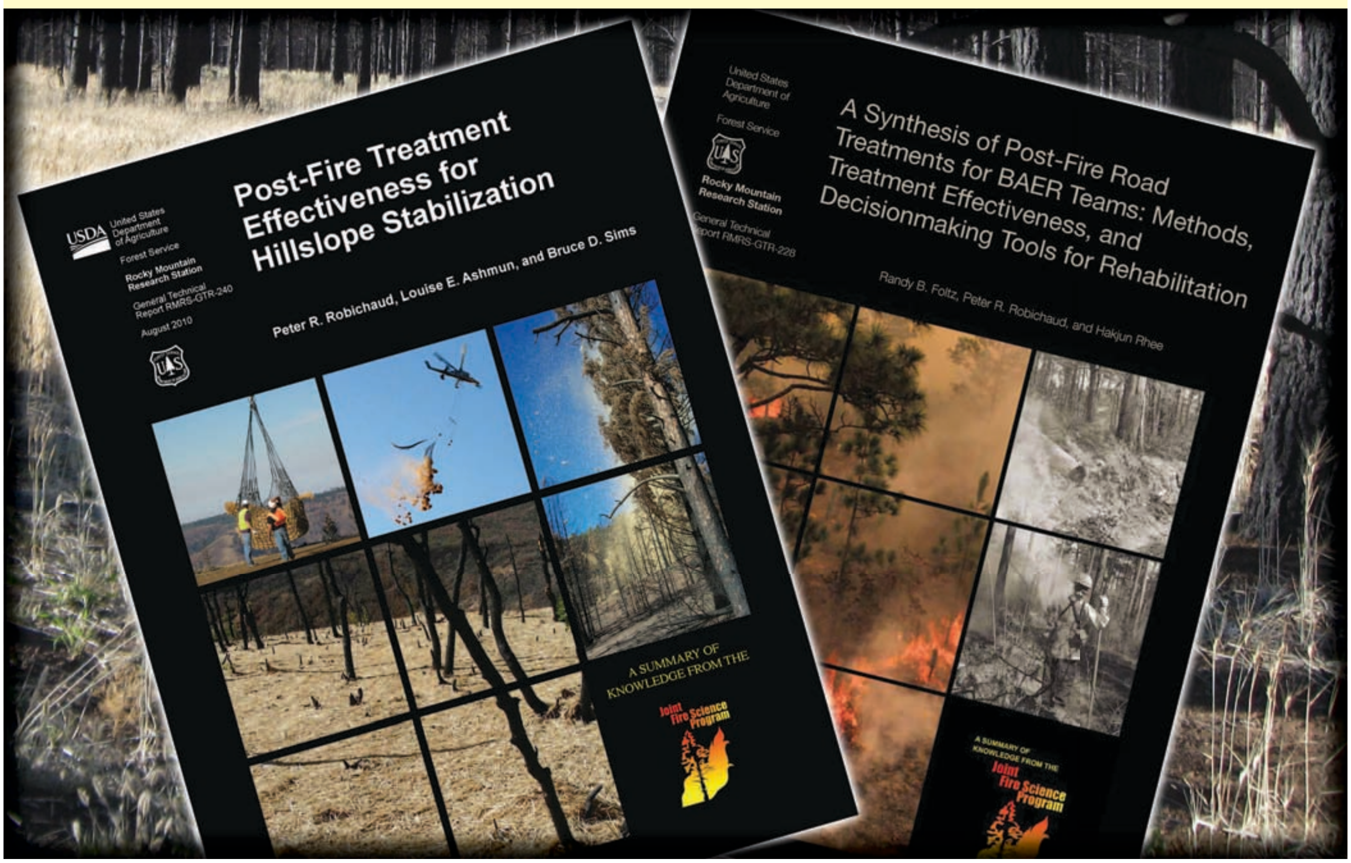
Joint Fire Science Program
Fire Science Digest
RESEARCH SUPPORTING SOUND DECISIONS
ISSUE 10 APRIL 2011

After the Fire is Out

Even before firefighters have left a burn site, a second wave of specialists is deployed. Their task: to assess the burn site; determine the level of risk to life, property, and ecological resources; and determine quickly the most effective postfire treatments for emergency stabilization and initial rehabilitation of the site. For the past 13 years, the Joint Fire Science Program (JFSP) has funded research on this critical phase of work, which often goes unnoticed after the fire is out. With support from the JFSP, scientists have made great strides in improving the tools available to assess postfire risks and evaluate the effects of available treatments, such as erosion barriers and postfire seeding. The suite of tools includes syntheses that recap the latest research findings and improved computer models to facilitate assessment of risks and threats after wildfires. These tools can help managers choose the best treatments to implement postfire stabilization and rehabilitation. This digest presents a synopsis that will help postfire team specialists and land resource managers respond with confidence to the aftermath of wildfire.



The year 2000 marked one of the worst, and most expensive, fire seasons on record in the United States, with most of the damage concentrated in the West. The wildfire management costs to the federal government alone ran more than $2 billion in 1 year, according to the U.S. Government Accountability Office (GAO). Since that landmark fire year, conditions have not improved; if anything, the situation is worse. The GAO estimates that the acreage burned and wildland fire costs have doubled since the beginning of the decade.

A large part of fire management cost is postfire treatment, beginning at times even before the fire is completely contained. Two postfire treatment measures, emergency stabilization and short-term rehabilitation, are intended to minimize runoff, flooding, erosion, sedimentation, debris flow, and other adverse effects that may threaten valued resources downstream from the burned area.

A large part of fire management cost is postfire treatment, beginning at times even before the fire is completely contained.

“Fire in the West is common and natural,” says Peter Robichaud, a research engineer at the Rocky Mountain Research Station, “so postfire erosion is also natural.” Fire suppression, heavy fuel loads, and more severe fires, however, have tended to increase erosion rates beyond what might be considered natural. In addition, population expansion into undeveloped areas puts more infrastructure at risk from postfire effects and jeopardizes human lives and safety.

The relative costs of emergency stabilization and rehabilitation compared to the costs of fire suppression vary widely from fire to fire but have followed an escalating trend as the severity and extent of wildfire rises. In 2003 and 2006, the GAO issued reports to Congress detailing the need for better information on the costs of postfire management, including improved monitoring of treatment effectiveness and data collection and analysis to augment anecdotal reports and photos (GAO-03-430, GAO-06-670).

For 13 years, Robichaud and other researchers, with support from the JFSP, have been gathering and analyzing information on the effectiveness and ecological effects of postfire treatments. Researchers have also evaluated methods used to assess risk. Together, they have put together a suite of syntheses based on the most current research and created greatly improved computer models to assist teams of specialists in this critical phase of wildfire management, which often occurs with less fanfare than the containment and suppression phases. These readily available tools can help guide efforts to make the most of limited financial resources and bolster the confidence of specialists charged with making postfire treatment decisions.

Risk Assessment

For wildfire occurring on or adjacent to Department of the Interior (DOI) and U.S. Forest Service (USFS) lands, teams of specialists are immediately deployed to perform a preliminary assessment of the burn site: Burned Area Emergency Response (BAER) teams from the USFS and Emergency Stabilization and Rehabilitation (ESR) teams from the DOI. In the first hours and days after a fire, these professional responders must determine the threats of potentially damaging postfire rain events and the risks to resources downstream of the burned area. The teams must also weigh the treatment costs against the resource values potentially at risk and then determine the most effective short-term treatment depending on a number of variables, including the amount of exposed soil and the probability of significant rainfall within a certain timeframe after the fire.

Using this information, the teams—which consist of experts from a range of disciplines, including hydrology, soil science, forestry, engineering, and ecology—are charged with drawing up a written assessment to guide treatment plans and estimate costs under very tight time constraints, about 7 to 10 days, or deciding that no action is justified. In addition, they are responsible for implementing emergency

Keith Stockmann

A BAER team assesses potential threat probability of debris flows to infrastructure and possible treatments following the largest fire in Los Angeles County’s recorded history.

stabilization measures, such as applying straw mulch on hillslopes to protect critical infrastructure or habitat.

Postfire treatment decisions are generally based on comparing the benefits gained to the treatment costs, which in turn, requires that a monetary value be applied to the resources being protected. This is no easy task, especially when the resource is an asset not bought or sold in the marketplace. When there are clearly defined market prices for a commodity, such as a house, bridge, or road, calculating the cost of replacement is fairly straightforward. However, the values of ecosystem services, threatened and endangered species, and native vegetation are not well established in the marketplace, and the teams often grapple with the problem of assessing the value of noncommodity assets.

The reporting process used by the USFS requires a cost/risk analysis that assigns a dollar value to the values at risk (VAR), while DOI reports are based on qualitative information. A survey of USFS and DOI team specialists conducted by Dave Calkin, a research forester with the Rocky Mountain Research Station in Missoula, Montana, revealed shared concerns about the validity of the process and the difficulty of placing a value on nonmarket resources, whether qualitative or quantitative. In addition, the respondents reported that the assessment was usually not completed until the end of the evaluation process.

The researchers aimed to determine what improvements could be made in resource valuation for postfire risk assessment. Calkin's team observed and surveyed BAER and ESR teams and assessed resource valuation methods. Field observations and onsite interviews were performed after three large fires: the Mason Gulch Fire in Colorado in July 2005, the School Fire in southeastern Washington in August 2005, and the Gash Creek Fire in western Montana in August 2006. All three fires occurred on USFS and adjacent private lands.

This is an example of a postfire straw mulch application.

The written survey that followed cast a broader net, soliciting feedback from a larger number of experienced team members214 i n allc oncerning what improvements might make operations more efficient. Responses were nearly equally divided between the USFS (104 responses) and DOI agencies (110 responses). There were several common threads among the survey responses. The teams specifically cited difficulties conducting a cost/benefit analysis in the short timeframe and difficulties assessing VAR, especially for nonmarket resources, which make up more than half of VAR included in postfire reports.

Calkin's team also observed inefficiencies in the use of maps. "We saw that the teams spent a lot of time assessing burn severity, looking at the soils and the condition of the vegetation," says Calkin. In areas where no impacts on VAR are likely to occur, such as a remote fire in a wilderness area, burn severity may not matter as much as in an area with downstream resources deserving protection.

There was also some confusion regarding the terms threat and risk. Threat is the likelihood of occurrence of a physical event, such as potentially damaging flooding or erosion. Risk is the probability of loss or damage to something of value. For example, if a flood washes out a drainage, but the watershed functions as it did before the fire and there are no assets downstream, there is no risk. "A risk is attached to something that you care about, such as a school, a campground, sensitive species, or cultural resources," says Calkin.

Valuation Process

Resources routinely evaluated to which a real monetary value can be assigned include roads, buildings, public utilities, and bridges. Calkin found in his survey that these resources were directly monetized by: soliciting information from experts, such as local economic resource specialists and engineers; examining historical data from earlier reports; and using team judgment drawing from past experience.

On the other hand, assessing the value of public health and safety, resources that are frequently identified in the postfire environment, is problematic. How do you put a market price on public safety or human life? Both USFS and DOI personnel agreed with the JFSP research team that a price should not be set on those values, despite the availability of economic formulas that are often used to do so in other contexts.

Survey respondents also shared concerns about setting a price on other nonmarket values, such as wildlife, native terrestrial vegetation, and cultural and historical artifacts, which are typically identified VAR in postfire assessments. Clearly, a more analytical approach to valuation of nonmarket resources was needed to assist team specialists in making decisions within tight timeframes.

The research team reviewed several systems used to assign a dollar value to nonmarket goods and services. Of these, the implied minimum value (IMV) was deemed most appropriate. According to the JFSP final report, IMV valuation is based on the amount that is spent, the treatment cost to avoid a negative outcome, and the amount of risk reduction received for the money spent. The concept is basically a break-even analysis. For example, if the goal is to protect trout habitat, the value of a treatment with a sure likelihood of protecting that habitat is twice as valuable as a treatment with a 50 percent likelihood of failing. You have to recognize that outcomes in the postfire environment are very uncertain," says Calkin. That uncertainty should be part of the decision process."

"Very few team members have economic training, but they make this type of decision on a regular basis," says Calkin. "We tried to put the information in terms that forest managers can understand, using simple concepts from investment theory."

To assist the professional responders in performing these valuations, Calkin's team devised the VAR Calculation Tool, an economics decision support tool that is based in Microsoft Excel and accessible from the Internet. To use the tool, the user first enters data on each VAR—life, safety, market, and nonmarket. The threat(s) to the VAR appear on a map, and the user divides the map into zones. Each zone is evaluated on a separate worksheet, and the tool creates a summary worksheet. The user also enters information on the probability the threat will occur, the associated treatment cost, and the probability of treatment success. If the VAR has a market value, the user enters the cost of repair or replacement, and the tool performs a cost/benefit analysis. If the VAR is a nonmarket resource, the tool calculates the IMV. The results of the calculation are used to determine whether a treatment is justified. Nonetheless, monetizing nonmarket resources will likely remain controversial despite the improvements offered by the VAR Calculation Tool.

Fire Name	Santiago Fire			
Location	Orange County, CA	Live Oak Canyon		
Date	11/18/2007			
EACH MAP ZONE REPRESENTS A SYSTEM OF LINKED TREATMENTS AND ASSOCIATED VALUES AT RISK				
MAP ZONE D - VALUES AT RISK (VAR)				
Map link #	*Life and Safety*	Description		
	Debris Flow and flood threat	Throughout canyon floor adjacent to streams		
PLEASE NOTE: IF PUBLIC SAFETY IS A FACTOR, B/C RATIO SHOULD NOT BE RELEVANT AND SHOULD STRICTLY BE AN ACCOUNTING EXERCISE				
Map link #	*Non-Market: Cultural Values*	Description		
Map link #	*Non-Market: Ecological*	Description		
Map link #	*Market Values: Direct*	Description		Total
	4 Structures	Assumed to be residential	$	2,321,092
	1 water tank	estimated - no data available	$	100,000
			$	-
Map link #	*Market Values: Loss-of-Use*	Description		
			$	-
			$	-
			$	-
		Probability of experiencing the loss with no treatment (enter as decimal)		0.500
		Source of loss probability with no treatment: Select Source...		
		Market Resource Value	$	2,421,092
TREATMENT DESCRIPTION				
Map link #	*Proposed treatment*			Total
	Hydromulching upper watershed - 41 acres		$	143,680
			$	-
			$	-
		Probability of experiencing loss if treatment occurs (enter as decimal)		0.375
		Source of loss probability with treatment: Select Source...		
		Total Treatment Cost	$	143,680
VAR CALCULATION RESULTS				
		REDUCTION IN PROBABILITY OF LOSS		0.125
		EXPECTED BENEFIT OF TREATMENT	$	302,637
		Expected Benefit/Cost ratio of treatment for market resources only (economically justified if > 1.0)		2.1
		IMPLIED MINIMUM VALUE OF PROTECTING NON-MARKET RESOURCE VALUES		JUSTIFIED
Comments				

Non-Market Values Literature | View Literature

The spreadsheet of this map zone was created with the VAR Calculation Tool webpage and pertains to the 2007 Santiago Fire in California.

Between 2007 and 2010, 18 assessments were carried out on wildfires on USFS lands using the VAR tool. Keith Stockmann, an economist with the USFS Northern Region, has been involved in a program to train teams to use the VAR tool, which is helping the USFS select more effective postfire treatments. “We are still getting up to speed with the tool,” Stockmann says. “We have tended to use it for large and expensive fires where the regional team coordinator has a sense that postfire effects could be severe.”

This project and the training program revealed the need for a data management system: to cope with the massive amount of information gathered by the teams; better integrate existing GIS information with on-the-ground assessments by personnel; and make assessment and treatment choices even more efficient.

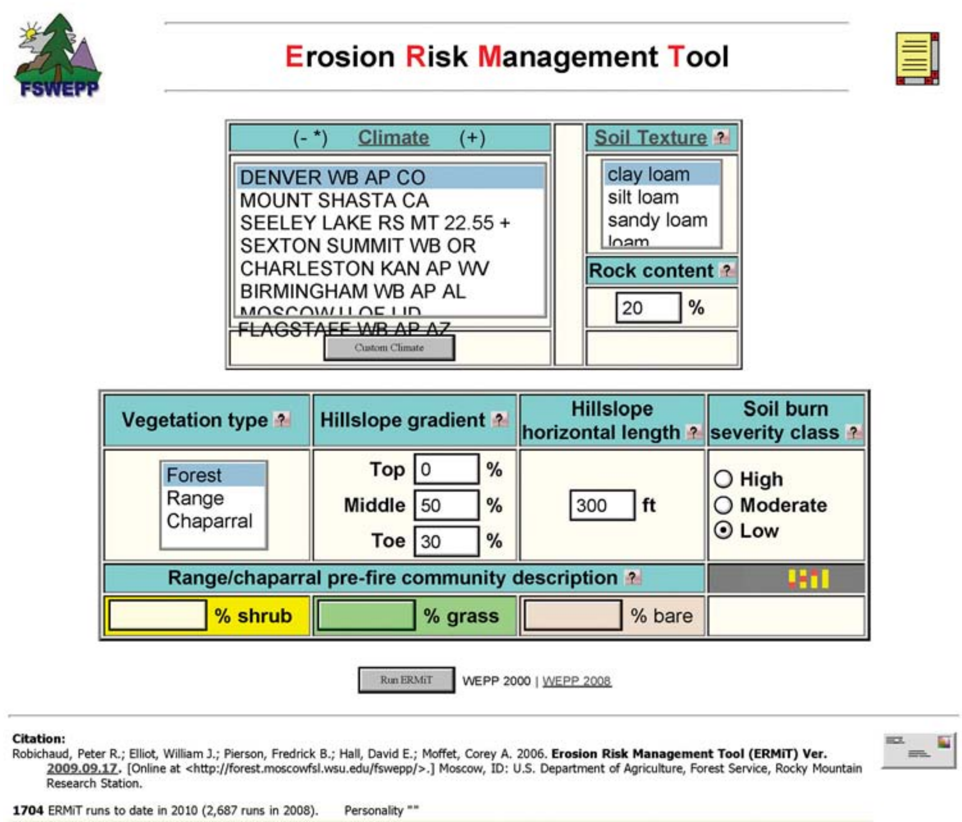
Erosion Risk Management Tool: ERMiT

When a fire has been contained and the soil burn severity has been assessed, land resource managers keep a close eye on the sky. Precipitation, from light rainfall to drenching downpours, is hard to predict, and bare soil devoid of vegetation is prone to severe erosion during a hard rain. There is a very small, and not easily predictable, window of opportunity for treatments to be implemented.

Since the mid-1990s, Rocky Mountain Research Station research engineers have been developing modifications to the Water Erosion Prediction Project (WEPP) model—an agricultural erosion prediction model developed by the U.S. Department of Agriculture (USDA) in 1985—that enable WEPP to make runoff and erosion predictions for forest environments. However, the WEPP model must be downloaded to a personal computer with a Windows operating system and presents quite a steep learning curve for the user. “WEPP is very complicated,” says Robichaud. “We used to have lots of workshops because the users would forget the input parameters, and it would take 2 days for them to get back up to speed.”

To facilitate better access to the erosion prediction capabilities of WEPP, a suite of simplified user interfaces was developed for a range of climates and forest disturbances, including roads, fires, and timber harvest. These interfaces, accessed and run on the Internet, require users to input only the essential variables. All other variables are stored in databases. As a result, only outputs that match information and formats needed by land managers for their work are generated.

To gauge the probability of a rain event that could lead to postfire erosion, and to estimate the potential benefit of treatments, with support from the JFSP, researchers have created a Web-based Erosion Risk Management Tool, ERMiT. ERMiT is a probability based model rather than an ‘average’ model, because average does not take into account the high variability of events,” says Robichaud, who led the effort to expand the USFS WEPP erosion prediction tools to include the ERMiT interface. ERMiT uses information on climate, soil properties, and burn severity, along with known variation in these parameters, to estimate hillslope erosion in probabilistic terms on burned and



Erosion Risk Management Tool (ERMiT) interface user input page.

recovering forest, range, and chaparral lands. These estimates are made for untreated and treated (seeding, straw mulching, and erosion barriers such as contour-felled logs or straw wattles) hillslopes. ERMiT output is a distribution of erosion amounts for single rainfall events with a probability of occurrence for each of 5 postfire years. These erosion rate distributions are shown graphically and in tables.

Though ERMiT was first designed using data from western states, it can easily be adapted for any location. "Our client base is not just the western United States, but around the world," says Robichaud. During the 2009 Victoria wildfires in Australia, for example, the model was used for all the postfire evaluations. "I was down there with the U.S. postfire assessment teams," says Robichaud, "and we put Australian information into the program's database for their locations. They were very pleased."

The model has been very well accepted since it was launched in 2002. In 2009, for example, 60,000 WEPP model runs were performed from the ERMiT interface. The VAR Calculation Tool and ERMiT are among a growing number of tools available online to assessment teams to guide postfire stabilization planning and effective use of limited funds to achieve maximum benefit. Since the USFS WEPP interfaces, assessment tools, publications, and other resources became available via Internet, Robichaud estimates that the site averages one million "hits" per year.

Postfire Hillslope Treatment Decisions

In its 2003 and 2006 reports, the GAO raised concern about the costs of common postfire hillslope treatments and the lack of hard data on their relative effectiveness in mitigating runoff and erosion. In response, a synthesis of postfire hillslope treatment effectiveness, supported by the JFSP and posted on the BAERTOOLS Web site, was completed. It includes reviews of research from the past decade and gives an effectiveness rating for six common burned hillslope treatments: straw mulches, wood mulches, hydromulches, soil binders, contour-felled logs, and straw wattles. The researchers compared the various treatments under three precipitation scenarios: high intensity, low intensity, and high total amount.

A key factor in predicting the likelihood of postfire erosion is the amount of ground cover or the proportion of exposed mineral soil on the site. When hydrologic conditions are good, with high levels of vegetation and litter, soil losses due to erosion are minimal. With severe fire, ground cover can be reduced to 10 percent, resulting in high surface runoff and erosion.

Dry mulches—straw, wood strands, and wood shredsge nerally outperform other treatments in reducing postfire hillslope erosion. They provide immediate ground cover, trap sediment, and have reduced erosion rates by up to 90 percent or more. Wood strand mulches stay in place longer than straw

Tools Available for BAER Teams

The tools—including syntheses, models, and field guides—developed to assist team specialists are available at one convenient location: **http://forest.moscowfsl.wsu.edu/BAERTOOLS/**.

- ERMiT - Erosion Risk Management Tool
- VAR Calculation Tool for Assessing Post-fire Values-at-Risk
- Post-Fire Hillslope Treatment Synthesis
- Post-Fire Road Treatment Synthesis
- Field Guide for Mapping Post-Fire Soil Burn Severity
- Field Guide for Assessing Post-Fire Infiltration and Water Repellency
- BAERCAT - Burned Area Emergency Response Treatments Catalog

The latest version of GeoWEPP, the geospatial interface for WEPP, is available at **http://www.geog.buffalo.edu/~rensch/geowepp/**.

After the 2007 Cascade Complex Fires in Idaho, a trailer-mounted blower pulled by a tractor applies straw mulch as postfire treatment down slope from a road.

An aerial application of straw mulch treatment is released over the target area by a cargo net suspended below a helicopter. (photo from Burned Area Emergency Response Treatments Catalog by C. Napper (2006); p. 25)

mulches because of their greater resistance to wind displacement. Both straw and wood mulches can be applied aerially, an important advantage when large, areas in remote areas require treatment.

Robichaud estimates the cost of aerially applied agricultural straw treatment at about $700 to $1,400 per acre and the cost of wood strand mulch at about $2,000 to $3,500 per acre. WoodStraw™ , a product made by Forest Concepts in Auburn, Washington, is a manufactured erosion control product made from waste material generated in wood veneer production. "It has proven to be effective, but it is expensive," says Robichaud. A newer product under evaluation is wood shreds, which can be made onsite. "You cut the burned trees and put them in a tub grinder to shred the material," says Robichaud. When processed and applied locally on small burned areas, wood shreds can be cost effective, but spreading this mulch aerially over larger areas would add to the expense.

Other treatments that may be suitable for specific conditions include hydromulches, soil binders, contour-felled logs, and straw wattles. Hydromulch is a mixture of water, short fibers such as wood and paper, and tackifiers that help "glue" the mixture to the soil; seeds are often added to the mix before application. Its ability to bind with the soil surface allows it to stay in place in areas of high wind, but it degrades rapidly, generally within 1 year. Although hydromulches have not yet proven to be as effective as other mulches in reducing postfire hillslope erosion, new formulations of hydromulch components are constantly being developed and tried, especially in areas where high winds make straw mulching ineffective. Another treatment type, chemical soil surface treatment, such as soil binders, surfactants, and polyacrylamide, has had limited testing and has not yet proven to be effective in reducing postfire erosion.

Combinations of treatments can take advantage of a single application process to achieve multiple goals; for example, seed is often mixed into dry or wet mulches. Combination treatments, however, can be costly. In some cases though, the expense of multiple treatments and/or treatment maintenance may be justified if a resource at risk has a very high value. This was the case after the 2002 Missionary Ridge Fire in Colorado, which placed the intake structure of a dam at risk of sedimentation. The reservoir above the dam provides water for the city of Durango. In this case, contour-felled logs, straw mulch, hand seeding, and straw bale check dams and debris racks were all implemented at higher than normal rates. In addition, the hillslope and channel barriers were cleaned out and maintained after individual storms.

On a burned hillslope in southern California, straw wattles were installed in a staggered layout.

Though wood and straw mulches perform better than other available treatments in most postfire applications, the teams may adjust their recommendations according to factors specific to the burn site. Environmental and climate factors vary from site to site, as do the expected hydrologic response within the area and the extent and patchiness of high and moderate soil burn severity. In addition, access and proximity to existing roads, treatment cost and availability, and the VAR that are being protected will affect treatment choices.

All Roads Lead Somewhere

In Calkin's survey, roads top the list of resources at risk that have a monetary value; 76 percent of the respondents reported that roads are "always" or "usually" encountered after fire. Nationwide, replacement costs for road structures represent 20 percent of postfire rehabilitation expenses, but this varies widely from fire to fire. For example, after the 2005 School Fire in Washington, the initial assessment report placed a value of $2,650,000 on damages to private residences, somewhat less than the $2,850,000 for roads and bridges.

Roads not only have intrinsic, measurable economic value, but they also serve as gateways to other valuable resources, such as homes, campgrounds, other infrastructure, recreational areas, hunting territory, and logging sites. While a decision to take no action to protect resources in remote wilderness areas is a valid one, it is rarely an option for roads. Every road is somebody's favorite road," says Randy Foltz, a research engineer with the Rocky Mountain Research Station in Moscow, Idaho.

Despite a significant amount of published and gray literature, assessment teams have noted the lack of a convenient synthesis of information needed to make road rehabilitation decisions in the short timeframe allotted to postfire assessment. In response to this expressed need, Foltz and colleagues have sifted through the relevant literature; sounded out engineers, hydrologists, and soil scientists using questionnaires and personal interviews; and reviewed the road rehabilitation procedures and analytical tools commonly used by teams to make decisions about road treatments after a fire. The study, funded by the JFSP and also available on the BAERTOOLS Web site, focused on western USFS regions 1-6 (Northern, Rocky Mountain, Southwestern, Intermountain, Pacific Southwest, and Pacific Northwest).

After most wildfires, the probable increase in peak flow rates can be a problem for water passing structures such as culverts; thus, one of the first tasks for the team hydrologist is to estimate the potential peak flows that will likely affect the road structures. The two most commonly used models for estimating postfire peak flow are based on watershed and land use characteristics that estimate runoff from various storms. "These models are fairly easy to use with a little training, and most hydrologists are familiar with them from day-to-day work," says Foltz. A model developed by the U.S. Geological Survey (USGS) uses regression equation methods to estimate peak flow in larger watersheds, greater than 5 square miles; the USDA Natural Resources Conservation Service's runoff curve number method is typically used for smaller watersheds. The USGS regression equation method has also been incorporated into a Web-based GIS tool, StreamStats, which provides access to stream flow and engineering design information. These tools, however, were created for general engineering design. Roads are not typically designed with wildfire in mind, and the road structures for water passage and erosion prevention often fail after a wildfire.

If the team determines that road structures are at risk for damage, they choose treatments designed to mitigate that risk, such as installation of rolling dips or water bars, upgrading culverts, and road ditch armoring. Installed treatments, along with poststorm culvert cleanouts and increased road maintenance, are commonly recommended to ensure that water, sediment, and debris continue to either move past roads or are captured and removed before causing significant problems. However, few road treatment installations have been systematically studied to determine whether the treatments were effective at maintaining adequate water and debris passage and mitigating road erosion and damage.

Team specialists tend to rely on their own professional judgment as well as input from local soil scientists, hydrologists, and road engineers to determine the probability of success for a particular treatment. Since the majority of fires that require treatments include road treatments, it is important to

Greta Burles

Poe Cabin Fire in Central Idaho in 2007.

The collection point of a rolling dip with a road fill slope (an area where collected water will drain) and armored with rock after the 2007 Tripod Fire in Washington.

continue improving the decisionmaking tools used to make treatment decisions and to increase our knowledge of road treatment effectiveness.

Good Seed after Bad?

Over the course of the 20th century, postfire seeding consisted of a succession of approaches based mainly on trial and error. As scrutiny of the cost of postfire rehabilitation intensified, critical evaluation of the practice of seeding to stabilize scorched land emerged as a high research priority. Species of grasses and other plants were chosen because of their purported ability to stabilize soil and reduce erosion, but without sufficient regard to their effectiveness or other effects on vegetation. "Seeding has been viewed as a way to meet the goals of stabilization," says Peter Z. Fulé, a professor for the School of Forestry at Northern Arizona University, "but we are not always meeting those goals."

With the support of the JFSP, Fulé's research team, led by ecologist Donna Peppin, conducted an evidence-based systematic review of the literature on postfire seeding effectiveness in the forests of the Intermountain West from 1970 through 2009. In addition, the team examined postfire reports to track trends in seeding during that period and conducted a survey of major seed suppliers in the region. This rigorous retrospective analysis uncovered numerous studies of varying quality and experimental rigor on seeding treatment effects on soil stabilization, invasion of nonnative species, and plant community recovery over time. These included published, peer-reviewed articles and technical reports, as well as unpublished reports and graduate student theses and dissertations, the gray literature, which is not easily accessed by the research community, much less resource managers. In this process, the research team rated the quality of evidence supporting different findings. Replicated and controlled experiments were considered high quality, while anecdotal observation was deemed low quality.

The team found 94 studies that met the review criteria, including replicated and randomized experimental design, review papers, and expert opinions. Across the board, in studies of postfire stabilization and treatment effectiveness, controlled experiments, rather than observational research, are the exception, not the rule. "In our systematic review process, we found that in the past there was not much quantitative information comparing seeded versus unseeded areas," says Fulé. Among the earlier research papers, through 1999, only a small percentage met high quality standards, including quantitative data and experimental controls. However, from 2000 forward, the percentage of high quality papers increased. Not surprisingly, prefire information is usually lacking, since wildfires seldom announce where they will strike next, and it is rare for a wildfire to occur on an area that has been extensively studied in the past. In addition, most studies focus on short-term effects (1-3 years postfire) although, a few long-term studies do exist. Studies have been conducted since the 2000 Cerro Grande Fire on the Bandelier National Monument that spread to the nearby Los Alamos National Laboratory in New Mexico, and since the 2002 arson-ignited Hayman Fire around the Pike and San Isabel National Forests in Colorado.

As the quality of studies improves, the evidence suggests that seeding is less effective than was previously assumed. Ken Stella, a master's student at Northern Arizona University, recently tested and analyzed the effects of three postfire seeding treatments on three sites in Arizona. The three categories of postfire seeding treatments included native grasses, a mixture of native and nonnative species that have been used in past fire rehabilitation, and no treatment. Stella found a great deal of variability. Fire at the highest elevation, 7,900 feet (2,400 meters), with the greatest moisture showed some response, but overall, postfire seeding was not effective in increasing cover or reducing nonnative plants. In fact, after 1 year, vegetative cover on the unseeded treatment was the same as on both seeded treatments, about 40 percent. "This was an experimental rather than an observational study," says Fulé. "It would be helpful to do more of this kind of research."

As the quality of studies improves, the evidence suggests that seeding is less effective than was previously assumed.

Moreover, research findings raise concerns about the use of some short-lived, noninvasive and nonnative grasses often used in emergency postfire seeding. These grasses are established quickly and have been found more effective than native species at stabilization, but they may impede the natural recovery of native grasses, shrubs, and trees.

In response to the concern over the use of nonnative species, data from forested ecosystems documented in USFS burned area reports indicate an increased use of native seed since 2000. Although less expensive than mulching or installing erosion barriers, seeding has a high price tag; between 2000 and 2007, the cost of postfire emergency seeding in the western United States nearly doubled that of the previous 30 years, averaging $3.3 million per year. However, this is still less than other hillslope treatments. The trend in recent years has been to seed smaller areas at a greater cost.

Pete Fulé

After the 2010 Schultz Fire in Coconino National Forest, Arizona, the site was seeded with a wheat hybrid to help with postfire stabilization.

In addition to price, commercially available native seed is not always appropriate for a particular ecosystem. Producing local genotypes in sufficient quantities to meet the need for postfire seeding is difficult and expensive. Fulé says that seed companies have been very efficient at selecting species that can be produced in high volume with good germination rates, but as policy changes to use native seeds, it tends to restrict what the company can grow." Seed suppliers reported that their ability to supply the market is also constricted by the lack of a consistent and reliable demand." Wide fluctuations in demand also constrain seed companies from investing in native species, much less local genotypes. One way to encourage investment in the market is to consistently use native grasses in ecological restoration projects and on road construction sites. That could produce a more stable market," says Fulé.[1]

Seeding on Rangeland

Much of the current knowledge on postfire seeding has been gained from research on hillslopes in forested sites and chaparral. Less is known about the practice on western rangelands. Jan Beyers, a plant ecologist with the USFS Pacific Southwest Research Station, has collaborated with Fulé on seeding studies funded by the JFSP on forested land and is currently expanding the research to include an evaluation of the practice on rangeland in the western United States. The goals for seeding on hillslopes, where downslope erosion from precipitation is a concern, are different from those for relatively flat rangeland, where erosion from wind—eolian erosioni s a concern.

In a retrospective review of the literature published in 2004 in Conservation Biology, Beyers traced the history of seeding and assessed its effectiveness from the late 19th through the 20th century. In the Intermountain West in the late 1880s, the land was so overgrazed that many of the original species such as perennial bunchgrasses were lost. "Grasses on these lands today are a poor shadow of what they once were," says Beyers. During a prolonged and severe drought at the end of the 19th century, the damage worsened. Millions of cattle died and ate everything they could find before they died. To make matters worse, nonnative cheatgrass was introduced inadvertently from contaminated seed and spread over much of the range and altered the fire regime from one of infrequent fire to one of frequently recurring and more extensive fire.

Since the 1930s, seeding after fire on rangeland served a dual purpose, to stabilize the soil and to improve pasture on grazing lands, often using nonnative annual grasses for short-term stabilization, perennial grasses for long-term protection, and nonnative forbs such as alfalfa for stabilization and nitrogen fixation. More recently, crested wheatgrass, a nonnative perennial bunchgrass, has been found effective in postfire seeding; it is good forage, fire tolerant, and can compete with cheatgrass. "Team responders can't treat an existing infestation, but they can intervene after fire to keep cheatgrass from expanding," says Beyers. Much rangeland seeding now uses native species such as bluebunch wheatgrass and Sandberg bluegrass.

Troy Wirth, USGS

This monitoring plot shows a successful seeding after the 2002 Trimbly Fire in Oregon. The seeded plants shown are native bluebunch wheatgrass, which was drill seeded, and sagebrush, which was seeded aerially.

[1] For more information on Fulé team's research, see: Peppin, D.L., P.Z. Fulé, C.H. Sieg, J.L. Beyers, and M.E. Hunter. 2008. Post-wildfire seeding in forests of the West: Trends, cost, effectiveness, and use of native seed. JFSP Final Report 08-2-1-11.

Lack of good documentation is a hindrance in assessing the effectiveness of treatments on rangeland. "We don't have preburn data on vegetation composition and natural erosion rates," says Beyers. Most research has been conducted after prescribed fire, which rarely burns as hot as wildfire." Moreover, when postfire monitoring of seeding is conducted, it is usually confined to areas that burned hot and appear to need seeding. Team specialists tend not to monitor areas that do not burn as hot or areas that look as if they will regenerate on their own," says Beyers.

Preliminary results of Beyers' research indicate that:

- In treating large burned areas, seeding rangeland is more effective than seeding forested areas.
- Germination rates may improve by 50 percent or more if ground application of seed is followed by mechanical drilling or dragging a chain over the seeded area, but this is expensive and may not be feasible for large and/or steep burned areas. The cost may be defensible, however, if the goal is to stem an invasion of cheatgrass.
- One study showed that there was more erosion after seeding than with no treatment, perhaps because of the ground disturbance that occurred during the process.
- If precipitation occurs shortly after seeding, germination rates increase. The use of mulch is rare in rangelands, but it could help hold the seed in place until the rains come.
- In forested areas, the goal of seeding is to provide a "quick fix" of cover using annuals to hold the soil in place until the understory gets established. On rangelands, using perennials immediately after fire can help stabilize the soil and meet the longer-term needs of rehabilitation and restoration.

The Right Tools in Experienced Hands

Emergency postfire stabilization and rehabilitation efforts must be tailored to protect local resources given local conditions. Tools such as ERMiT and the VAR Calculation Tool add an extra measure of confidence to team specialists making critical decisions under high pressure in short timeframes. The syntheses present the results of the most current research in an easily digestible format, so practitioners under time pressure can readily access the relevant information without having to sift through a mountain of published articles or read every final report submitted to the JFSP. As research progresses, more comprehensive syntheses will be posted on the BAERTOOLS Web site.

The suite of tools now available online is intended to assist postfire responders in making decisions based on sound science. These tools provide a wealth of scientific information, including models, catalogs, syntheses, and field protocols, to supplement the combined experience of the professional team members charged with making critical decisions immediately after wildfire.

Suggested Reading

Beyers, J.L. 2004. Postfire seeding for erosion control: Effectiveness and impacts on native plant communities. Conservation Biology 18 (4): 947-956.

Calkin, D.E., K.D. Hyde, P.R. Robichaud, J.G. Jones, L.E. Ashmun, and D. Loeffler. 2007. Assessing post-fire values-at-risk with a new calculation tool. Gen tech report. RMRS-GTR-205. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. **http://www.fs.fed.us/rm/pubs/rmrs_gtr205.pdf**.

Calkin, D.E., J.G. Jones, and K.D. Hyde. 2008. Non-market resource valuation in the post-fire environment. Journal of Forestry 106 (6): 305-310.

Peppin, D., P.Z. Fulé, C.H. Sieg, J.L. Beyers, and M.E. Hunter. 2010. Post-wildfire seeding in forests of the Western United States: An evidence-based review. Forest Ecology and Management 260 (5): 573-586.

Robichaud, P.R., L.E. Ashmun, and B.D. Sims. 2010. Post-fire treatment effectiveness for hillslope stabilization. Gen tech report. RMRS-GTR-240. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. **http://www.fs.fed.us/rm/pubs/rmrs_gtr240.pdf**.

Stella, K.A., C.H. Sieg, and P.Z. Fulé. 2010. Minimal effectiveness of native and non-native seeding following three high-severity wildfires. International Journal of Wildland Fire 19 (6): 746-758.

National Interagency Fire Center
Joint Fire Science Program
3833 S. Development Ave.
Boise, ID 83705-5354

OFFICIAL BUSINESS
Penalty for Private Use, $300

FIRE SCIENCE DIGEST ISSUE 10 APRIL 2011

JFSP *Fire Science Digest*
is published several times a year.
Our goal is to help managers
find and use the best available
fire science information.

Credits

Writer – Elise LeQuire

Managing Editor – Tammie Adams
tmadams@blm.gov

Design and Layout – Jennifer Kapus
Mary_J_Kapus@blm.gov

Tim Swedberg
Communication Director
Timothy_Swedberg@nifc.blm.gov
(208) 387-5865

AN INTERAGENCY RESEARCH, DEVELOPMENT, AND APPLICATIONS PARTNERSHIP

Learn more about the Joint Fire Science Program at

www.firescience.gov

John Cissel, Program Manager

(208) 387-5349

National Interagency Fire Center

3833 S. Development Ave.

Boise, ID 83705-5354